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Air tanker and helitanker use in Canada 1978-1984

W.G. Murray

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Abstract

An analysis of the use of air tankers and helitankers in forest fire suppression by Canadian agencies was carried out for 1978-1984.

The statistics provide an overview of their use on a national scale and on an east (Manitoba and east) versus west (Saskatchewan and west) basis, a comparison of skimmer operations versus landbased operations, and the trends in helitanker use. One pronounced observation was that skimmer air tankers consistantly delivered a greater volume of litres per hour than any other delivery system.

Résumé

Ce document analyse l'emploi d'avions-citernes et d'hélicoptères-citernes par des organismes canadiens dans la lutte contre les incendies de forêt, de 1978 à 1984.

Les statistiques donnent un aperçu de l'utilisation de ces aéronefs à l'échelle nationale, avec des comparaisons entre l'Est (à l'est de la frontière Saskatchewan-Manitoba) et l'Ouest (à l'ouest de cette frontière), et une analyse comparative des résultats obtenus à l'aide d'hydravions, d'une part, et d'avions terrestres, d'autre part. Elles révèlent aussi les tendances de l'utilisation des hélicoptères-citernes. Une importante constante se dégage de l'analyse: la capacité des hydravions (en litres déversés à l'heure) est supérieure à celle de tous les autres appareils utilisés.

AIR TANKER AND HELITANKER USE IN CANADA 1978-1984

INTRODUCTION

The use of air tankers and helitankers is now an accepted method of combating forest fires in all parts of Canada.

Aerial suppression techniques, fire load, and economic considerations have influenced suppression agencies in restructuring their organizations and adjusting tactics and techniques to increase their suppression efficiency.

To determine the effects and extent of these operational adjustments, fire and aerial suppression statistics for the period 1978 to 1984 inclusive were compiled, and an analysis was carried out on suppression hours flown by fixed and rotary wing air tankers, volumes of water and short- and long-term retardants delivered to fires, area burned, and the annual fire load.

METHODS

The data for the number of fires and area burned were drawn from reports published by Ramsey and Higgins (1981, 1982), from Provincial records (copies on file at PNFI), and from reports tabled at the Annual Meetings of the Canadian Committee on Forest Fire Control (CCFFC)[1] (National Research Council of Canada 1979 to 1985).

Data concerning hours flown and volumes of water and retardants delivered were drawn exclusively from CCFFM Reports[2]. The inconsistency between hours flown and volumes delivered made it impractical to use past performance figures to derive estimates which would approximate the missing data for any particular agency.

Hours flown by rotary wing aircraft in the aerial bombing role were in some cases not separated by the agencies from other fire-related activities. The flight hours that are tabulated in this report on the summary sheets were only those hours determined to be directly associated with the delivery of retardants and suppressants. Some agencies made partial annual entries and others did not record any helitanker volume delivery data for much of the seven-year period. The entries appear as nil for the years where data are missing.

Preliminary tabulations covering the years 1978 to 1982 were forwarded to the respective agencies along with corresponding graphical presentations for confirmation, correction, and/or comment. The corrections and comments concerning this five-year period were duly noted and the database was then

[1]Became Canadian Committee on Forest Fire Management (CCFFM) as of 1985.

[2]The factors 2.471 acres = 1 hectare, and 1 imperial gallon = 4.546 litres were used to convert the data.

increased to seven years by adding 1983 and 1984 data. New tables and graphs were prepared to cover the entire seven years under analysis.

RESULTS

The National Scene

The national annual averages for the seven-year period, 1978 to 1984 inclusive (Table 1), were: number of fires, 9.0 thousand; area burned, 2.2 million ha; hours flown by fixed wing air tankers, 10.1 thousand*; hours flown by rotary wing air tankers, 4.8 thousand**; and, volume of water and retardant delivered, 149.4 million L. A further breakdown of these annual averages by air tanker type (Table 2) revealed that even though skimmer and land-based air tanker hours were almost equal, i.e. 5040 hours (skimmers) and 5019 hours (land-based), volume deliveries were disproportionate. Land-based air tankers delivered an annual average of 20.4 million L whereas skimmers averaged 94.8 million L, i.e. 4.6 times the volume delivered by land-based air tankers. Based on total volume delivered, 14 per cent was delivered by land based air tankers, 63 per cent by skimmer air tankers and 23 per cent by helitankers. However, because some of the helitanker data was missing, the actual percentages would be at variance, i.e. per cent volume delivered by helitankers would increase and the percentages for skimmer and land-based air tankers would decrease accordingly. The averages were misleading without reference to the range of variations from which they were derived. A more meaningful approach was to select a base year and make comparisons relative to it. When the years 1979 to 1984 were compared with 1978, major deviations were identified relative to the base year. The year 1979 showed a 29 per cent increase in the number of fires and this was responsible for the destruction of an additional 2.4 million hectares, i.e. an increase of 843 per cent, while aerial delivery of water and retardants increased by only 44.9 million L, an increase of 56 per cent.

Although the number of fires in 1980 was only 15 per cent greater than in 1978, area burned increased by 4.2 million hectares (+1480 per cent) and aerial deliveries increased by 98.6 million L (+122 per cent). The same anomalies were evident in 1981 and 1982 when the number of fires increased by 31 and 14 per cent, burned area increased by 3.7 million ha (+1281 per cent) and 1.4 million ha (+496 per cent), and aerial deliveries increased by 119.5 million L (+148 per cent) and 80.1 million L (+99 per cent), respectively. In 1983, 14 per cent more fires burned 0.9 million more ha (+320 per cent) and volume delivered increased by 111.6 million L (+138 per cent).

The picture became somewhat brighter in 1984. For that year there was a 23 per cent increase in the number of fires over 1978 but the area burned was only 0.5 million ha greater (+165 per cent) and the volume of water and retardant delivered increased by 26.2 million L (+32 per cent). Even though the increase in the number of fire starts was never greater than 31 per cent of the 1978 total, the extent of areal losses indicated that the frequency of fire starts (the fire load) must have overtaxed suppression resources.

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* Hours that were reported to CCFFC are assumed to be hours flown on aerial attack.

**This average includes only those hours for which volume data was recorded.

Table 1. Summary 1978-84: Volumes delivered, number of fires, area burned, and hours flown by fixed-winged and rotary-winged air tankers in Canada

	Fixed-wing air tankers				Fires		Helitankers					
	Litres delivered			Hours			Litres delivered			Hours	Total hrs.	Grand total delivered[4]
Year	Water	Retardant	Total	flown	Number	Area(ha)	water[1]	retardant[2]	Total	flown[3]	flown	(L)
1978	56 833 800	16 430 152	73 263 952	6 960.8	7 640	286 342	4 250 492	3 182 200	7 432 692	815	7 775.8	80 696 644
1979	73 019 416	27 825 262	100 844 678	10 489.1	9 847	2 700 534	21 824 382	2 953 414	24 777 796	4 268.1	13 935.2[5]	125 622 474
1980	106 617 575	19 349 129	125 966 704	12 867.8	8 794	4 524 429	53 292 399	0	53 292 399	5 735.4	17 658.2[6]	179 259 103
1981	108 402 688	34 336 976	142 739 664	14 401.2	9 980	3 954 171	56 000 536	1 456 115	57 456 651	10 341.8	23 778.8[5]	200 196 315
1982	90 634 844	18 759 871	109 394 715	10 081.4	8 734	1 706 801	50 850 410	553 706	51 404 116	8 674.0	18 755.4[5]	160 798 831
1983	157 511 932	9 162 803	166 674 735	8 788.1	8 737	1 204 029	25 642 269	0	25 642 269	2 261.2	11 049.3[5/6/7]	192 317 004
1984	71 986 114	15 563 544	87 549 658	6 820.2	9 401	759 750	17 086 240	2 238 677	19 324 917	1 659.5	8 479.7[5/7/8]	106 874 575
Average				10 058.4	9 019	2 162 294				4 822.1		149 394 992

[1]All water volumes not recorded.
[2]All retardant volumes not recorded.
[3]Only those hours associated with volumes delivered recorded.
[4]Some agencies neglected to record volumes delivered by helitankers.
[5]No rotary wing hours or volumes recorded by Manitoba.
[6]No rotary wing hours or volumes recorded by British Columbia.
[7]No rotary wing hours or volumes recorded by Alberta.
[8]No rotary wing hours or volumes recorded by Saskatchewan.

Table 2. Hours flown and volumes delivered by skimmer, land-based, and rotary wing air tankers in Canada

	Hours flown			Volume delivered (L)				Per cent delivered		
Year	Skimmer	Landbased	Helitanker[1]	Skimmer	Landbased	Helitanker	Total Delivered[2] (L)	Skimmer	Land-based	Helitanker
1978	3 862.3	3 098.5	815.0	56 986 329	16 277 623	7 432 692	80 696 644	71	20	9
1979	4 831.3	5 657.8	4 268.1	74 613 112	26 231 566	24 777 796	125 622 654	59	21	20
1980	7 127.9	5 739.9	5 735.4	106 617 575	19 349 129	53 292 399	179 259 103	59	11	30
1981	6 092.2	8 309.0	10 341.8	108 402 688	34 336 976	57 456 651	200 196 315	54	17	29
1982	4 828.0	5 253.4	8 674.0	88 393 121	21 001 594	51 404 116	160 798 831	55	13	32
1983	6 079.9	2 708.2	2 261.2	157 202 113	9 469 622	25 642 269	192 317 004	82	5	13
1984	2 456.3	4 363.9	1 659.5	71 886 330	15 663 328	19 324 917	106 874 575	67	15	18
Total	35 277.9	35 130.7	33 755.0	664 104 268	142 329 838	239 330 840	1 045 765 126	447	102	151
Aver.	5 039.7	5 018.7	4 822.1	94 872 038	20 332 834	34 190 120	149 395 018	64	14	22

[1]Hours for which volume data recorded.
[2]Reported volumes.

The actual number of fires fought annually by air tankers was reported by only some agencies. These fire agencies reported that their air tankers were dispatched to fight anywhere from 9 to 78 per cent (Table 3) of the total number of annual fire occurrences in their respective jurisdictions from 1978 to 1982. During this period, Newfoundland and the Northwest Territories made the most use of air tankers.

Table 3. Per cent of the total number of fires fought by airtankers by reporting agencies

	Agency				
Year	Nfld. %	Que. %	N.B. %	Sask. %	N.W.T. %
78	35	16	9	29	71
79	78	16	10	35	46
80	68	18	12	30	38
81	32	21	11	33	34
82	44	21	13	22	32

The objective at the outset was to present an overview of trends in the use of water and retardants in aerial suppression operations, but the agency summaries did not lend themselves to such a simple analysis. The year to year variations in the data were probably due to season to season differences in fire load, fire frequency, location of occurrences, weather parameters, and different man-up and equipment availability levels.

Due to the abundance of strategically located water bodies suitable for skimmer use and the prominence of helitankers in suppression operations, all fire protection agencies east of Saskatchewan, except New Brunswick, relied on skimmers and, to a much lesser degree, on helitankers to deliver water to combat their fires. Saskatchewan and the agencies west and north thereof used either land-based retardant tankers or a combination of skimmer and land-based aircraft for water and long- and short-term retardant delivery. British Columbia regularly used retardants and water in their helitanker operations, but the other western and northern agencies used helitankers predominantly, if not exclusively, for water delivery, to complement their fixed-wing air tanker operations.

The Provinces and Territories

Newfoundland used skimmer type air tankers exclusively in their aerial operations. The disproportionately high volume of water delivered in 1979 suggests that air tankers were used in support of all phases of suppression (Table 4). The low volume delivered in 1980 was related to the small number of fire starts (60). These 60 fires represented less than one half their seven-year average.

The volume delivered in Quebec by skimmers appeared to be governed by fire starts. The peak year in terms of fire occurrences, hours flown, volume delivered by air tankers, and area burned (ha) was 1983 (Table 5).

Table 4. Volume dropped, number of fires, area burned, and hours flown in Newfoundland during 1978-84

Year	Air tankers				Fires		Helitankers					Grand total dropped (L)
	Litres dropped			Hours flown	Number	Area (ha)	Litres dropped			Hours flown	Total hours	
	Water	Retardant	Total				Water	Retardant	Total			
1978	5 124 251		5 124 251	274.0	209	4 681					274.0	5 124 251
1979	20 166 056		20 166 056	749.0	172	32 418					749.0	20 166 056
1980	1 659 290		1 659 290	69.0	60	954					69.0	1 659 290
1981	4 116 689		4 116 689	247.0	132	13 087					247.0	4 116 689
1982	4 364 160		4 364 160	233.0	165	4 392					233.0	4 364 160
1983	2 780 000		2 780 000	144.0	138	16 470					144.0	2 780 000
1984	4 477 810		4 477 810	304.0	101	7 743					304.0	4 477 810

Table 5. Volume dropped, number of fires, area burned, and hours flown in Québec during 1978-84

Year	Air tankers				Fires		Helitankers					Grand total dropped (L)
	Litres dropped			Hours flown	Number	Area (ha)	Litres dropped			Hours flown	Total hours	
	Water	Retardant	Total				Water	Retardant	Total			
1978	26 566 359		26 566 359	1 035.6	1 160	3 672					1 035.6	26 566 359
1979	11 835 672		11 835 672	507.0	615	3 209					507.0	11 835 672
1980	24 937 243		24 937 243	858.0	861	13 177					858.0	24 937 243
1981	28 950 255		28 950 255	1 013.6	1 114	2 480					1 013.6	28 950 255
1982	26 382 817		26 382 817	952.5	1 202	7 970					952.5	26 382 817
1983	86 288 000		86 288 000	2 691.0	1 652	242 222					2 691.0	86 288 000
1984	7 900 880		7 900 880	323.0	683	3 081					323.0	7 900 880

Nova Scotia's operations evolved from predominatly skimmer use with supplementary helitanker support, to a predominantly helitanker operation in recent years (Table 6).

New Brunswick (Table 7) used only land-based fixed wing air tankers. These aircraft delivered short- and long-term retardants plus varying amounts of water. Eighty-one per cent of the total volume delivered in New Brunswick for the seven-year period was made up of short- and long-term retardants.

Small amounts of long-term retardant were used in aerial operations by Ontario in 1978 and again in 1979 (Table 8), but the most widely used suppressant was water, which was delivered by skimmers and helitankers. The use of helitankers appeared to be related to the number of fire starts. Presumably they were pressed into service as and when required.

Small quantities of long term retardants were delivered in Manitoba by Saskatchewan air tankers under the mutual aid agreement in 1978 and again in 1980 (Table 9), but the provincial skimmers and helitankers fought fires with water only. The annual volumes transported by skimmers increased significantly after 1978 (Table 9). Because there is no indication of the number of fires actually fought by air tankers, there is no way of knowing whether this increase was due to the air tankers working in a support role or whether they were dispatched to a larger number of fires. Incomplete helitanker volume data precluded any worthwhile conclusions but, from the increase in hours flown by the helicopters, it can be assumed that the annual volumes delivered increased accordingly.

Saskatchewan used skimmers and helitankers exclusively for water delivery, and land-based aircraft as long-term retardant tankers (Table 10). The annual volumes of water surpassed the quantity of long-term retardant deliveries in proportions ranging from approximately 4:1 to 10:1 with a seven year average of 7:1. The imbalance was likely due to the frequency of fire occurrences and the proximity of water sources to the majority of fires. Hours flown and volumes delivered by helitankers increased year by year, with the largest upsurge being in 1981 when the number of fire starts increased by 2.8 times (177 per cent) compared to 1978, and the volume of water delivered increased by 97.2 times (9616 per cent).

Alberta's skimmer, land-based, and helitanker data from 1978 to 1979 showed that the ratio of retardant deliveries by land-based air tankers to water deliveries by skimmers increased from approximately 2:1 to 3:1 (Table 11). Approximately equal volumes of water and retardant were dropped during the 1980 and 1981 seasons. The 1982 fire season was comparable to 1980 in terms of fire starts and area burned, but the water-to-retardant ratio increased from 1:1 to 3:1. In terms of areal losses 1983 was a light fire year, even though the annual number of fires increased approximately 100-fold. Relative to 1978, the area burned decreased by 5000 ha (65 per cent) and retardant volume deliveries declined by 50 per cent; however, this figure was still twice that of water. Fire starts in 1984 (1370) were comparable to the 1980 fire season (1348 fires), but the area burned was 0.6 million ha (88 per cent) less and volume deliveries decreased by 7.8 million L (44 per cent). However, the quantity of retardant delivered exceeded water deliveries by 1.2 times. From 1978 to 1982 the output by fixed wing air tankers increased by nearly six times and by helitankers by almost 22 times. In 1983 the fixed

Table 6. Volume dropped, number of fires, area burned, and hours flown in Nova Scotia during 1978-84

Year	Air tankers: Litres dropped Water	Air tankers: Litres dropped Retardant	Air tankers: Litres dropped Total	Air tankers: Hours flown	Fires: Number	Fires: Area (ha)	Helitankers: Litres dropped Water	Helitankers: Litres dropped Retardant	Helitankers: Litres dropped Total	Helitankers: Hours flown	Total hours	Grand total dropped (L)
1978	577 297		577 297	119.1	793	739	430 415		430 415	70.2	189.3	1 007 712
1979	525 781		525 781	85.5	682	755	134 791		134 791	26.8	112.3	660 572
1980	235 619		235 619	121.0	439	979	851 011		851 011	88.4	209.4	1 086 630
1981	59 734		59 734	20.5	449	370	180 476		180 476	14.1	34.6	240 210
1982	72 827		72 827	19.7	491	617	839 283		839 283	52.9	72.6	912 110
1983	28 231		28 231	10.1	332	448	468 647		468 647	36.5	46.6	496 878
1984	30 276		30 276	11.7	446	594	426 278		426 278	25.5	37.2	456 554

Table 7. Volume dropped, number of fires, area burned, and hours flown in New Brunswick during 1978-84

Year	Air tankers: Litres dropped Water	Air tankers: Litres dropped Retardant	Air tankers: Litres dropped Total	Air tankers: Hours flown	Fires: Number	Fires: Area (ha)	Helitankers: Litres dropped Water	Helitankers: Litres dropped Retardant	Helitankers: Litres dropped Total	Helitankers: Hours flown	Total hours	Grand total dropped (L)
1978	655 760	1 545 640	2 201 400	935.8	468	2 397					935.8	2 201 400
1979	105 807	268 700	374 507	291.9	205	1 202					291.9	374 507
1980	6 810	635 600	642 410	393.3	222	2 611					393.3	642 410
1981		253 939	253 939	204.9	152	389					204.9	253 939
1982	2 067 157	2 116 708	4 183 865	1 212.0	279	6 536					1 212.0	4 183 865
1983	292 126	971 958	1 264 084	604.0	252	1 624					604.0	1 264 084
1984	13 638	407 503	421 141	271.0	233	645					271.0	421 141

Table 8. Volume dropped, number of fires, area burned, and hours flown in Ontario during 1978-84

Year	Air tankers: Litres dropped Water	Air tankers: Litres dropped Retardant	Air tankers: Litres dropped Total	Air tankers: Hours flown	Fires: Number	Fires: Area (ha)	Helitankers: Litres dropped Water	Helitankers: Litres dropped Retardant	Helitankers: Litres dropped Total	Helitankers: Hours flown	Total hours	Grand total dropped (L)
1978	5 767 147	100 102	5 867 249	481.9	940	7 524	55 098		55 098	2.6	484.5	5 922 347
1979	18 296 195	95 193	18 391 388	1 384.6	1 564	63 718	938 294		938 294	62.0	1 446.6	19 329 682
1980	30 915 278		30 915 278	2 499.7	1 779	560 325	11 818 964		11 818 964	625.6	3 125.3	42 734 242
1981	17 919 650		17 919 650	1 566.5	1 656	179 470	5 537 710		5 537 710	327.8	1 894.3	23 457 360
1982	11 103 241		11 103 241	655.9	1 396	3 892	259 577		259 577	11.2	667.1	11 362 818
1983	37 947 444		37 947 444	1 909.1	2 244	443 677	12 297 035		12 297 034	814.0	2 723.1	50 244 479
1984	15 603 630		15 603 630	706.9	1 240	120 424	2 292 999		2 292 999	123.5	830.4	17 896 629

Table 9. Volume dropped, number of fires, area burned, and hours flown in Manitoba during 1978-84

Year	Air tankers				Fires		Helitankers					Grand total dropped (L)
	Litres dropped			Hours flown	Number	Area (ha)	Litres dropped			Hours flown	Total hours	
	Water	Retardant	Total				Water	Retardant	Total			
1978	10 852 575	10 706	10 863 281	298.2	379	24 610	904 472		904 472	84.7	382.9	11 767 753
1979	13 957 129		13 957 129	822.0	644	82 424						
1980	26 281 562	3 182	26 284 744	1 252.7	1 082	514 292	267 987		267 987	70.0	1 322.7	26 552 731
1981	20 849 320		20 849 320	964.1	663	421 000						
1982	19 481 383		19 481 383	1 300.8	425	15 445						
1983	23 049 662		23 049 662	886.6	535	101 958						
1984	21 322 400		21 322 400	716.1	692	130 011						

Table 10. Volume dropped, number of fires, area burned, and hours flown in Saskatchewan during 1978-84

Year	Air tankers				Fires		Helitankers					Grand total dropped (L)
	Litres dropped			Hours flown	Number	Area (ha)	Litres dropped			Hours flown	Total hours	
	Water	Retardant	Total				Water	Retardant	Total			
1978	4 897 861	463 692	5 361 553	729.0	348	92 665	237 392		237 392	56.0	785.0	5 598 945
1979	3 658 621	913 855	4 572 476	916.7	413	229 669	304 582		304 582	65.0	981.7	4 877 058
1980	14 811 777	2 328 916	17 140 693	1 584.5	743	1 348 792	909 200		909 200	185.0	1 769.5	18 049 893
1981	21 666 236	2 774 878	24 441 114	2 076.8	965	164 797	23 065 949		23 065 949	2 700.0	4 776.8	47 507 063
1982	5 058 789	880 106	5 938 895	1 028.8	596	64 587	3 076 278		3 076 278	453.5	1 482.3	9 015 173
1983	5 982 536	727 360	6 709 896	579.4	437	52 172	3 705 581		3 705 581	345.9	925.3	10 415 477
1984	19 722 366	2 396 651	22 119 017	1 323.1	895	321 235						

Table 11. Volume dropped, number of fires, area burned, and hours flown in Alberta during 1978-84

Year	Air tankers				Fires		Helitankers					Grand total dropped (L)
	Litres dropped			Hours flown	Number	Area (ha)	Litres dropped			Hours flown	Total hours	
	Water	Retardant	Total				Water	Retardant	Total			
1978	1 756 074	3 047 170	4 803 244	1 023.0	653	7 791	1 882 726		1 882 726	254.6	1 277.6	6 685 970
1979	2 198 446	5 997 647	8 196 093	1 633.0	1 000	194 604	10 536 482		10 536 482	1 490.1	3 123.1	18 732 575
1980	6 729 671	7 104 767	13 834 438	4 415.0	1 348	672 460	34 508 345		34 508 345	4 027.7	8 442.7	48 342 783
1981	11 918 695	11 022 300	22 940 995	5 281.0	1 522	1 365 600	22 499 972		22 499 972	4 763.2	10 044.2	45 440 967
1982	21 929 904	6 492 893	28 422 797	2 392.9	1 257	688 383	41 050 380	21 821	41 072 201	5 830.0	8 222.9	69 494 998
1983	843 738	1 716 001	2 559 739	311.1	755	2 717						
1984	2 763 968	3 278 693	6 042 661	933.4	1 370	80 731						

wing output decreased to 55 per cent of the 1978 value, only to increase the following year and exceed 1978 by 7 per cent in response to a 50 per cent increase in fire starts. There was no helitanker data available for 1983 and 1984. The multi-role characteristics of the rotary-winged aircraft undoubtedly enhanced the role of these craft as retardant and water carriers. The volumes of water delivered by helitankers exceeded the combined water and retardant volumes delivered by fixed-wing airtankers in 1979, 1980, and 1982. Essentially 1983 was a year of minor fire activity and relatively low activity for the suppression organization.

British Columbia relied principally on retardants in their suppression program and used both land-based air tankers and helitankers to achieve their goal (Table 12). The small amounts of water applied by skimmers (1979, 1981, and 1983) were delivered by air tankers providing emergency support. British Columbia's utilization of helitankers apparently peaked in 1979 (no data for 1980 and 1983) and has since declined markedly in hours flown and volumes delivered. Retardant deliveries by air tankers peaked at 17.2 million litres in 1979, followed by 16.9 million litres in 1981. The general trend, though, was a marked decrease in retardant delivery after 1978.

Yukon Territory was a committed user of retardants in their fixed-wing operations, and water with their helitankers. Except for the year 1979, the use of retardant increased markedly over 1978. Fixed-wing air tankers delivered anywhere from 15 to 35 per cent of the total volume of retardant/suppressant used annually (Table 13). The use of helitankers in the support role undoubtedly led to the dropping of large volumes on very few fires. The numbers indicated a slight increase in dependence on helitankers for aerial suppression.

Northwest Territories conducted an integrated aerial operation during 1978-80. Skimmers and helitankers delivered water, and fixed-winged air tankers hauled retardants (Table 14). The use of skimmers was discontinued with one exception, when a CL-215 worked in that area under a mutual aid agreement in 1984. Helitankers remained the mainstay, with the annual output increasing until 1984 when the volume delivered was more than 20 times that of 1978. The use of retardant peaked in 1980 and the annual volume continued to decline thereafter. In 1978, 17 per cent of the volume used in aerial suppression was delivered by helitankers but by 1984 their output had increased to 85 per cent, basically a reversal of delivery proportions for fixed-wing to rotary-wing.

Retardant use was primarily concentrated in western and northern Canada. Therefore, in order to make allowances in the analysis for different aerial attack philosophies and techniques employed by fire suppression agencies, Canada was zoned into east and west using the Manitoba/Saskatchewan border as the demarcation line. All agencies in the eastern portion, except New Brunswick, relied primarily on skimmer air tankers and used water as the suppressing agent. New Brunswick used land-based air tankers exclusively to deliver water and short- and long-term retardants. In Manitoba, Ontario, and Nova Scotia, the skimmers were supplemented by helitankers. Actually, in Nova Scotia the trend in the latter years was a shift to a nearly total helitanker suppression system.

Table 12. Volume dropped, number of fires, area burned, and hours flown in British Columbia during 1978-84

Year	Air tankers: Litres dropped Water	Air tankers: Litres dropped Retardant	Air tankers: Litres dropped Total	Air tankers: Hours flown	Fires: Number	Fires: Area (ha)	Helitankers: Litres dropped Water	Helitankers: Litres dropped Retardant	Helitankers: Litres dropped Total	Helitankers: Hours flown	Total hours	Grand total dropped (L)
1978		10 185 768	10 185 768	1 796.0	2 308	50 083		3 182 200	3 182 200	195.0	1 991.0	13 367 968
1979	1 363 800	15 815 379	17 179 179	2 858.0	3 849	29 444	8 719 228	2 890 906	11 610 134	1 799.0	4 657.0	28 789 313
1980		4 580 000	4 580 000	945.0	1 743	65 578						
1981	500 000	16 403 782	16 903 782	2 105.0	2 737	106 568		1 456 115	1 456 115	1 280.0	3 385.0	18 359 897
1982		6 253 999	6 253 999	1 461.3	2 205	348 695		531 885	531 885	808.6	2 269.9	6 785 884
1983	240 042	3 727 000	3 967 042	1 087.0	1 704	67 363						
1984		7 620 000	7 620 000	1 788.0	3 063	19 908	5 692 000	2 177 534	7 869 534	822.0	2 610.0	15 489 534

Table 13. Volume dropped, number of fires, area burned, and hours flown in Yukon Territory during 1978-84

Year	Air tankers: Litres dropped Water	Air tankers: Litres dropped Retardant	Air tankers: Litres dropped Total	Air tankers: Hours flown	Fires: Number	Fires: Area (ha)	Helitankers: Litres dropped Water	Helitankers: Litres dropped Retardant	Helitankers: Litres dropped Total	Helitankers: Hours flown	Total hours	Grand total dropped (L)
1978		256 431	256 431	95.8	102	7 395	494 059		494 059	103.1	198.9	750 490
1979		181 852	181 852	36.0	65	7 347	338 140		338 140	54.7	90.7	519 992
1980		723 387	723 387	185.9	150	130 781	4 116 794		4 116 794	538.3	724.2	4 840 181
1981		478 257	478 257	184.5	91	35 159	1 744 709		1 744 709	837.2	1 021.7	2 222 966
1982		1 011 151	1 011 151	275.3	204	254 891	2 913 658		2 913 658	1 236.7	1 512.0	3 924 809
1983		833 782	833 782	296.1	198	43 006	3 300 996		3 300 996	645.1	941.2	4 134 778
1984		479 057	479 057	130.7	168	19 895	1 356 463		1 356 463	214.2	344.9	1 835 520

Table 14. Volume dropped, number of fires, area burned, and hours flown in the Northwest Territories during 1978-84

Year	Air tankers: Litres dropped Water	Air tankers: Litres dropped Retardant	Air tankers: Litres dropped Total	Air tankers: Hours flown	Fires: Number	Fires: Area (ha)	Helitankers: Litres dropped Water	Helitankers: Litres dropped Retardant	Helitankers: Litres dropped Total	Helitankers: Hours flown	Total hours	Grand total dropped (L)
1978	636 476	563 567	1 200 043	96.2	156	79 027	246 330		246 330	48.8	145.0	1 446 373
1979	911 909	2 488 799	3 400 708	518.2	380	1 989 133	411 449		411 449	70.9	589.1	3 812 157
1980	1 040 325	3 973 277	5 013 602	543.7	345	1 214 396	820 098		820 098	200.4	744.1	5 833 700
1981		2 431 692	2 431 692	305.1	311	984 932	900 108		900 108	200.0	505.1	3 331 800
1982		1 718 606	1 718 606	406.0	357	302 150	720 086		720 086	160.0	566.0	2 438 692
1983		1 003 698	1 003 698	206.5	342	226 841	5 524 060		5 524 060	390.8	597.3	6 527 758
1984	65 000	942 840	1 007 840	137.4	311	41 074	5 744 658	61 143	5 805 801	365.8	503.2	6 813 641

The western portion was made up of the Yukon and Northwest Territories and the three western provinces. Skimmers and helitankers were the primary water delivery vehicles and land-based air tankers were dedicated, for the most part, to long-term retardant delivery. In the Yukon, all water deliveries were made by helitankers but in British Columbia, helitankers were used for retardant delivery to supplement their fixed-wing fleet.

Although the average number of fires over the seven-year period was similar for both east and west, it is apparent that area burned, hours flown, and volumes delivered were quite different (Figure 1). Areal losses were substantially greater in the west, as were the number of hours flown by fixed-and-rotary winged aircraft, but the volume of suppressants/retardants delivered was less. The dominance of skimmers operating on very short turn-around times was no doubt responsible for the high output in the east. Hours flown by both fixed-wing and rotary-wing air tankers in the west was substantially higher, but the volume delivered was lower. Taking volumes delivered and dividing by hours flown by each type of land-based air tanker as recorded in the respective agency reports and dividing this by the payload of each type of air tanker, resulted in load numbers that were consistently less than one load per hour. This was presumably due to the fact that land-based air tankers were committed to fly out to the fire from a given base, deliver their load, and return to a fixed base for reloading. Hours flown may also have included ferry and training hours. Helitanker hours flown in the west were significantly higher than those flown in the east. Much of the volume data was not recorded so it was not possible to draw any firm conclusions regarding the general worth of the helitanker as a fire bomber. One interesting observation was that in those years when large areas were burned, the number of flying hours for helitankers rose accordingly.

The Canada-wide annual delivery summaries for fixed wing air tankers showed that the proportion of water to retardant was in the range of 3:1 in 1978, 1979, and 1981, 6:1 in 1980, and 5:1 in 1982 and 1984. In 1983 the proportion of water to retardant rose to 17:1 due to the much higher occurrence of fires in those areas of the country where water was the prime fire suppressing agent.

Annual deliveries of water and retardant by skimmer air tankers ranged from 74 to 94 per cent of the total volumes delivered by fixed-wing air tankers and from 54 to 82 per cent of all types of aerial delivery. These high proportions can be explained by the fact that five of the 11 fire protection agencies operated in regions where suitable water sources existed over vast portions of their jurisdictions. Consequently, in these zones they relied entirely on skimmer air tankers. In contrast, the agencies in the western zone capitalized on the use of skimmers to complement their land-based operations.

Annual helitanker delivery summaries showed that the water to retardant ratios were: 1978, 1:1; 1979, 7:1; 1980, no data; 1981, 38:1; 1982, 92:1; 1983, no data; and 1984, 8:1. British Columbia was the only agency which used retardants in conjunction with helitankers regularly, so the high water to retardant ratio was no surprise; however, had all helitanker drop data been recorded, the water portion of the ratios would have been much greater.

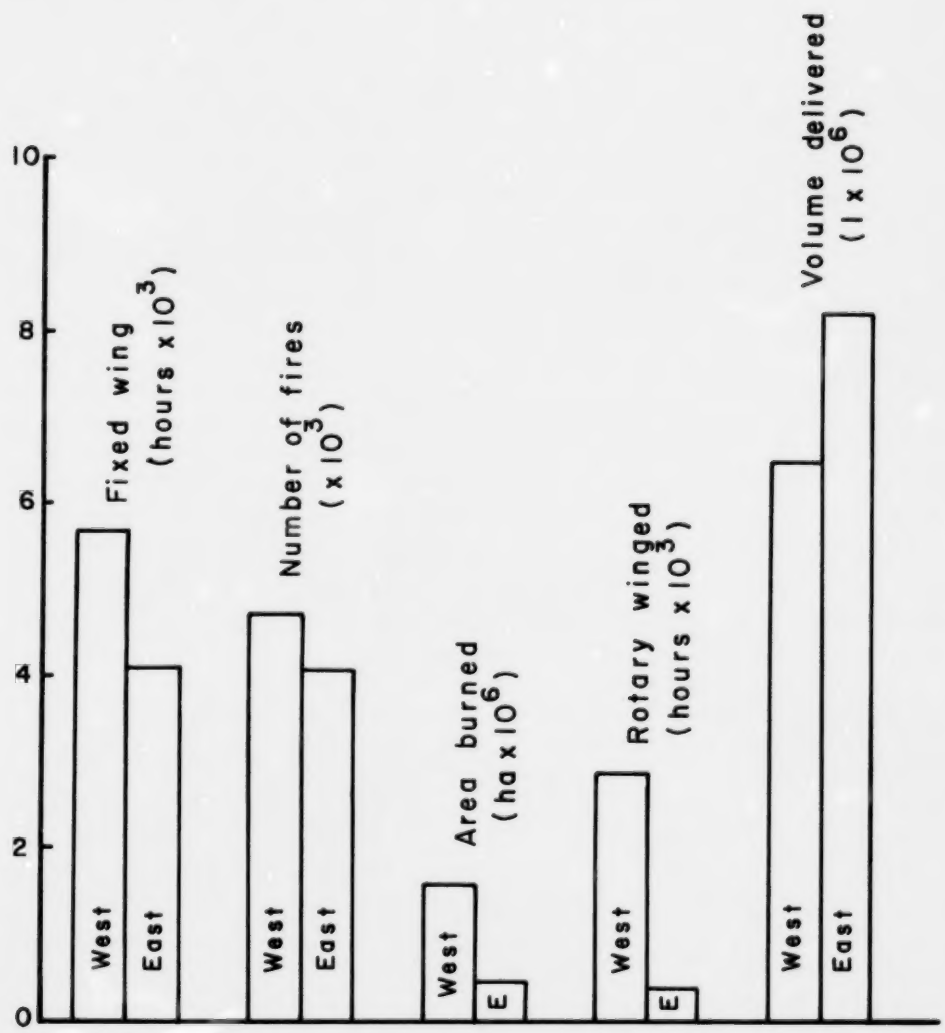

Figure 1. Seven-year fire statistics averages for eastern and western Canada.

It was apparent (Figure 2) that even though the average number of fires per year was in the range of 9000 there has been a steady decline since 1980 in hectares burned. 1980 was the peak year in terms of hectares burned. The extraordinarily high areal losses were due to the flammability of forest fuels and the inability of suppression forces to contain some fires during the initial burning period.

The greatest increase in volume of water delivered occurred in 1983 (Figure 3) and this was presumably due to the fact that nearly 2000 more fires occurred in the eastern portion of Canada where the agencies, except New Brunswick, relied solely on water as their suppressing agent. In general, water deliveries increased in all years relative to 1978 and the increases would have been even greater had all volume data been recorded. During those years for which helitanker retardant data are recorded, a lower volume of retardant was delivered for the subsequent years following 1978 even though the annual number of fire occurrences was higher (Figure 4). The quantity in litres per hour of flying time delivered by skimmer and land-based air tankers (Figure 5) declined for retardant tankers and increased for skimmers. Based on litres per hour, the volume delivered by land-based airtankers seldom exceeded 1 load per hour irrespective of tanker type or size.

CONCLUSIONS

The data appeared to indicate that each agency used the type of aerial tool that it deemed best suited for its particular operation.

During the period under review Newfoundland, Quebec, New Brunswick, British Columbia, and the Yukon Territory had the only protection agencies which maintained a consistent aerial forest fire suppression approach. The other agencies, while fairly consistent in the use of fixed wing air tankers, appeared to be involving more helitankers as their fire load increased. Increased use of helitankers was primarily in aerial support to ground crews, rather than in initial aerial attack, but they were also used for water delivery in fire suppression. This increased use of helitankers in forest fires did not appear to have much impact in reducing the area burned. Water volumes delivered by skimmers were on the increase, while the quantity of retardants delivered by land-based airtankers and helitankers declined compared to the base year 1978.

Few agencies indicated the proportion of total number of fires fought by aerial tankers, but the available data seemed to indicate that those agencies which had the resources to cope with multiple fire starts and whose strategy was rapid initial attack to reach the fires while they were still small, had the best chance of containing fires.

The annual number of hours flown by agencies on control missions was dictated by fire occurrences. It seems reasonable to conclude that air tankers were spending less time on campaign fires.

As more CL-215s are delivered to the various agencies an even more pronounced increase in the use of water will be apparent.

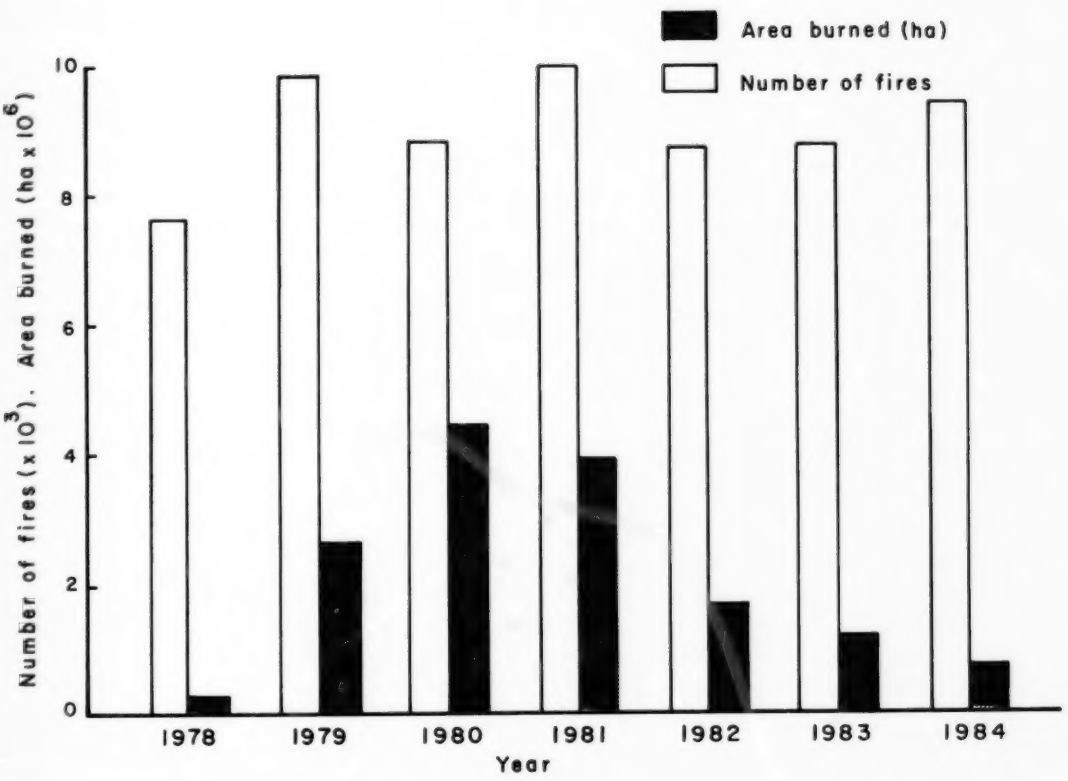

Figure 2. Number of fires and area burned annually for years 1978 to 1984.

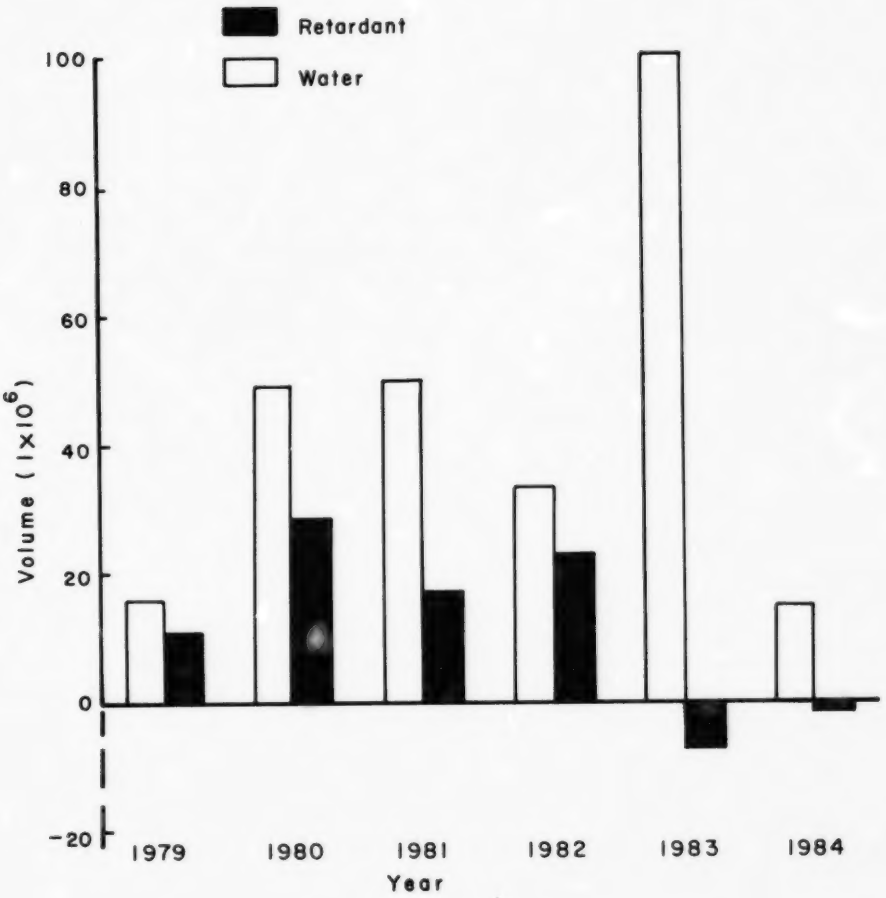

Figure 3. Changes in volumes delivered by fixed-wing air tankers for the years 1979-84 relative to 1978.

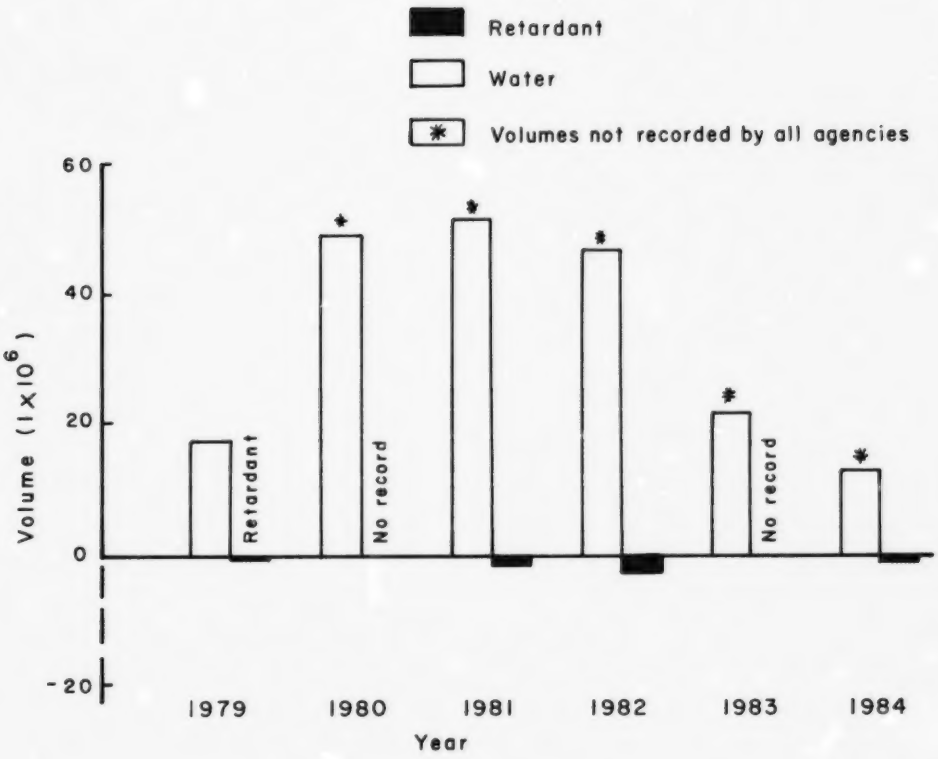

Figure 4. Changes in volumes delivered by rotary-winged air tankers for the years 1978-84 relative to 1978.

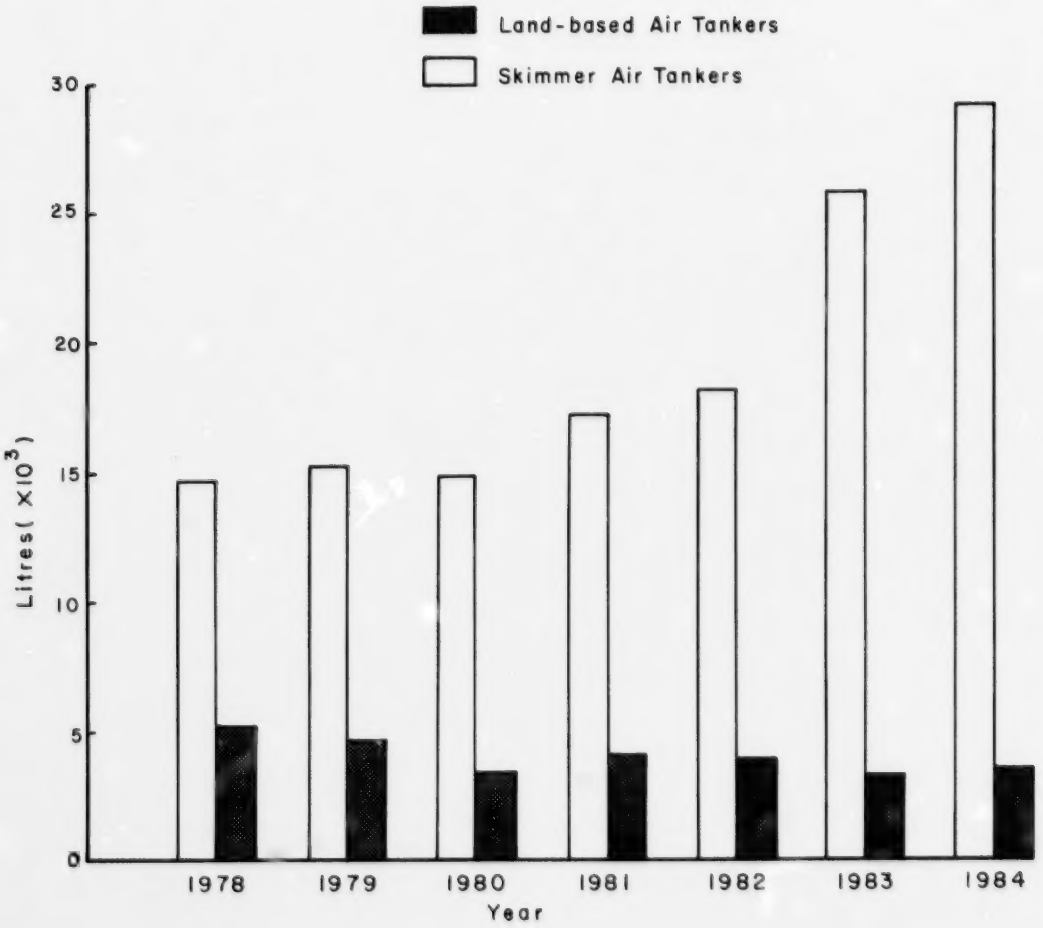

Figure 5. Litres per hour delivered by air tankers based on reported number of hours flown.

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